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THE BRITISH JOURNAL
OF
OPHTHALMOLOGY
OCTOBER, 1922

COMMUNICATIONS

THE DOYNE MEMORIAL LECTURE, 1922*

BY

J. BURDON-COOPER,

BATH

(*Concluded*)

We come now to consider cataract associated with well-marked constitutional conditions, diabetes being one of the most important of these. There is no doubt that genuine diabetic cataract exists. It is a disease of early life, and is seen typically in the rapidly-developing cataract of the serious and generally fatal glycosuria of young subjects. In a child it has been known to occur in a few hours and in other cases in a few days. It is subject to regressive metamorphosis and the whole lens may liquify and become absorbed. Spontaneous cure is commoner than in the ordinary senile type. The disease mainly involves the outermost layers of the cortex, and in its appearance resembles rapidly swelling traumatic cataract, presenting bluish-white asbestos striped opacity. Since it may appear at various ages, it occurs in many different forms. It cannot be differentiated with certainty in older people, as in them the prominent features may be those of senile cataract, and the diagnosis can only be certain when the disease is associated with cataract in early life. Its proportion to other forms, owing to this fact, varies considerably. Becker gave 1 per cent., Williams 8 per

* Read at the Oxford Ophthalmological Congress, August 7, 1922.

cent., Koineg 11 per cent. The true value probably lies between 2 and 5 per cent. It is quite usual to find types of cataract associated with diabetes which have nothing to do with the disease at all. In the case of punctate and subcapsular varieties it is most difficult to determine whether they are senile manifestations or are due to the disease. A rapid increase of myopia would be the clinical sign indicating diabetic cataract in an elderly person though hypermetropia has been known to occur. Myopia is probably the result of imbibition of water by the cortex lessening its refractive index and so reducing the strength of the concave meniscus relative to the nucleus. In certain cases of senile diabetes alterations in the epithelium of the ciliary body are present, and these in turn interfere with the proper nutrition of the lens. Diabetes as a cause of cataract was first reported by Berndt as early as 1834, and since his day observers have been divided as to the actual cause of the crystalline changes. Some attribute them to the presence of sugar in the blood and intra-ocular fluids. Koch in 1881 and Vansonneau in 1904 showed that the cause was not so much the presence of glucose on the intra-ocular fluids as the vicious influence of the diabetic state on the whole uveal tract. Hess thinks diabetic cataract is due to changes in the posterior surface of the iris similar to those observed in the ciliary body by Peters; others that the lens changes are coincidental, and are only indirectly due to the diabetic condition. We ask ourselves, naturally, what causes the ciliary alterations that produce the cataract? What is it that interferes with secretory activity of the ciliary epithelium, the analogue of the renal cells? Is it glucose or is it a factor of which the latter is only an indication? Magnus' experiments on the injections of glucose do not help much. It cannot be due to sugar concentration in the aqueous, as in grave cases with 6 per cent. to 10 per cent. of sugar in the urine the amount in the aqueous is 0·5 per cent. In the case I personally determined many years ago it was 0·4 per cent. with 7 per cent. of sugar in the urine. This amount is utterly unable to effect an opacity in the clear lens removed from the eye, and, in addition, sugar has been found in good healthy lenses in experimental pancreatic diabetes. A sharp distinction ought to be drawn between diabetic opacity and cataract. A lens rendered opaque by sugar can be cleared by placing it in water, provided no decomposition has taken place. Deutschmann's idea probably is the correct one, that there is local death of the cells through which abnormal diffusion takes place. What the factor is in determining this is at present unknown. Botlazzie and Scalinci think it is the organic acids which precipitate the alkaline proteid of the lens, but I have found the aqueous alkaline. The idea, I think, at present is that it is due to glucose. Diabetic cataracts are invariably white and unpigmented. This would imply an absence of

oxygen. The increased amount of cholesterin found in diabetic cataract seems to confirm this, as the latter, I believe, is a reduction product of a previously formed acid.

Viterbi and Foa say it does not depend on molecular concentration of the aqueous, and may possibly be due to slow chemical action of the glucose. Roemer suggests specific cyto-toxins formed in connection with products of intermediary metabolism; in short, a similar explanation to that which he gives for senile cataract, with which it is one and the same disease, and according to this view the diabetes would not be a direct but an indirect cause. In spite of all that has been done, our ideas as to aetiology are still inaccurate.

Of cataract occurring in diphtheria, typhus, meningitis, scarlet fever, variola, and loss of blood, we know nothing. That occurring in cholera has been attributed to the abstraction of water but is probably of cyto-toxic origin. The part played by syphilis, congenital or acquired, is not yet settled. There is a leaning to Von Michel's theory that specific lesions of the ramifications of the internal carotid, principally those supplying the retina and choroid, cause disturbances of nutrition and opacity.

It is freely admitted that recurring uveitis, usually syphilitic, gives rise to cataract. Regarding auto-toxaemia and intestinal toxaemia in particular, Professor Lewis, speaking some time ago on the aetiology of lenticular changes, stated that every patient presenting such a condition of the lens was suffering from intestinal toxaemia. In a series of 100 cases of incipient cataract taken at random to test the accuracy of this statement I found 80 per cent. showed a well-marked indicanuria.

Cataract is frequently met with in localities after epidemic poisoning by ergot. The general symptoms associated with it are muscle cramps and disturbances of sensation, and the cataract is usually bilateral, and in young people. Meyer attributed it to spasm of the internal ocular muscles. Kortnoff found that ergot cataract usually took three to twelve months to ripen, and then had all the appearances of senile cataract. The spasms produced by ergot affect unstriped muscle tissue. Many attribute it to spasm of the blood vessels and consequent interference with nutrition. So far, it has not been produced experimentally by ergotin.

The occurrence of cataract in tetany and convulsions has long been known, the exact aetiology being still a matter of investigation. Dor believes that the occurrence of convulsions, malformations of the thyroid cells, and defects of the enamel of the teeth form a symptomatic triad not to be ignored. He is of the opinion that we are no more justified in charging tetany or strumous teeth with the cataract than we are in blaming the cataract for the convulsions. Can tetanic convulsions produce cataract? This has been answered

in the affirmative by Peters, Schoen, Dor and others, who have reported cases of tetany followed by cataract. Possibly an accompanying cramp of accommodation, ciliary spasm and rupture of the zonular fibres may bring it about. Peters thinks that the lenticular changes are the result of a cyclitis. Dor, after sifting up the evidence, thinks that both the cataract and the convulsions are the result of some thyroid ferment circulating in the blood. Hesse and Phelps do not think that zonular cataract is the only affection of the lens in tetany since they observed within three years 34 juvenile cases in which tetany existed or had done so. These had total cataract or some other form of opacity in the lens. They concluded that it may be assumed with great probability that tetany is the aetiological element in zonular and many other forms of cataract at a pre-senile age. They do not identify tetany with tetanic convulsions and do not attribute the cause of the lens affection to these. The convulsions are only a partial phenomenon. Motor, sensory and vaso-motor disturbances and changes of metabolism are present in well-marked tetany, and it is from these that the characteristic trophic abnormalities, especially ectodermal ones effecting skin, hair, nails and teeth, and the lens, develop.

From experiments on rats it would appear that complicated nutritive disturbances due to a morbid condition of the blood are the aetiological factors.

The observations of Noël Paton and Findlay suggest that tetany is due to a defective action of the parathyroids. These ordinarily detoxicate a guanidin compound derived from muscular metamorphosis. Tetany occurs if this process is interfered with. Fuchs and Tribenstein claim to have found tetany and latent tetany in 88.2 per cent. of cases in pre-senile cataract, whereas such evidences were only found in 8.3 per cent. of control cases free from the disease. Cataract may follow removal of the thyroid and parathyroid either for experimental purposes or for surgical reasons. The aetiology of this cataract is uncertain, but the balance of evidence points to the cause being toxæmic and uncontrolled by sufficient thyroid and parathyroid secretion. Thyroidectomy is not always followed by cataract, and assuming the operation to be complete, some additional factor must be present to cause the disease in such cases. Major Kirkpatrick, from whose paper on the aetiology of cataract, kindly lent me for this lecture, I now quote, has seen cataract associated with hypothyroidism, and he suggests that the ocular condition might be dependent upon a deficient endocrine function to which tetany in all probability is to be attributed. The number of cataracts which may be ascribed to convulsions represent only a small proportion of primary cataracts met with, but it is quite possible that minor degrees of parathyroid deficiency which in itself

may be insufficient to cause convulsions, may be comparatively common and exert an important influence.

An interesting and important cataract from an aetiological point of view is that produced by naphthalene, first investigated in 1886 by Bouchard; it is finally accepted now that this cataract is due to a poisoning of the lens. Panas thought that it was due to retinitis produced by naphthalene, but Hess showed that the opacity preceded the retinitis which may be absent. Magnus and Peters thought it due to a shrinkage of the nucleus due to increased osmosis by the presence of salt in the aqueous, the outcome of alterations in the epithelium of the ciliary body, a conclusion arrived at through a study of the electrical conductivity of the aqueous. Hess showed that there was an increase in volume of the lens at the commencement with shallowing of the anterior chamber, and Salffner that the lens had increased both in weight and volume before any changes took place, the first visible indication of opacity being an augmentation in weight and volume amounting to 16 per cent. The first change results from the inability of the capsular epithelium to prevent the entrance of water. That the epithelium is involved is shown in its looser connection with the lens, and the occurrence of proliferation and mitotic division of its cells. An interesting feature is that naphthalene must be given by the mouth before cataract can occur. Animal lenses remain clear in a concentrated solution of the drug, and administration by any other method has failed to produce opacity. How the naphthalene acts, whether by producing some poison in its passage through the intestinal tract and final absorption by the blood, or that other substances are formed by the poisoning of the body we do not know, but it has been discovered that lenses absorb water quicker in the serum of animals poisoned with naphthalene than in the normal.

Napthalene cataract is one of *the* most important experimental cataracts, as of all the types it most resembles the subcapsular senile variety, and it gives us some indication where to look for the cause of the human disease.

Cataract due to heat and light, owing to its industrial importance, has received considerable attention during the last 15 years. We are largely indebted to the work of the Royal Society Committee, appointed in 1908 to investigate the aetiology of glassblowers' cataract, and numerous individual workers, among whom we may mention the late Dr. Burch, Gunn, Parsons, Anderson, Legge, Abney, Crookes, Hartridge, Hill, Robinson and Cridland in this country, and Meyhoefer, Hirschberg, Hess, Arlt, Peters, Burge, Birch-Hirschfeld and others abroad.

In order to appreciate how heat and light affect the eye it is necessary to refer to the spectrum, which to suit our purpose may be divided into three divisions. The invisible infra-red or heat

rays of wave lengths varying between 60000 and 7300 A-units, all of which, according to Hartridge and Hill, are absorbed by the iris. The visible spectrum comprised between 7200 and 3970, rays of which, when extremely intense, damage the retina, as in eclipse blindness, and the invisible ultra-violet or actinic rays which are most active chemically. Of the latter, those in close proximity to the violet of about 3550 may, if intense, reach the retina and cause damage. Those of shorter wave length still, and comprised between 3500-2950, are absorbed by the lens and converted by it into heat. It is these rays which are the active factor in the ultra-violet portion of the light given off from molten glass or metal. They are not the chief set but are only supplementary to the invisible heat rays beyond the red, which are by far the most potent. The lens absorbs probably all rays between 4000 and 2950. In the infra-red, rays longer than 23000 do not penetrate the eye at all. The larger amount comprised between 11000 and 13000, are absorbed by the lens, and are the active factor. Crookes and Dr. Burch have shown that it cannot be X-rays which produce post-cortical cataract, as none are emitted from molten metal or glass, and it is extremely improbable that it is purely ultra-violet light, as Crookes found that few ultra-violet rays emanated from the bottle makers' tank and that the infra-red rays were far more abundant. Schanz and Stockhausen found, on the contrary, a fairly rich emanation. As it is only those comprised between 3000 and 3500 (a comparatively small number) which could damage the lens and only a small fraction of these are absorbed by it and converted into heat, their effect must be small, but as they exist they cannot be ignored. The truth probably lies with both schools, and we may summarise it by saying that the cause is really absorption of the rays of light from both ends of the spectrum, namely, those between 11000 and 13000 in the infra-red and those lying between 3000-3500 in the ultra-violet and their conversion into heat in the lens. It is, in reality, the heat rays which determine the cataract and Cridland's designation "ray cataract" is as good a term as we could have. It is a matter of clinical experience that cataract is common in those exposed to great heat. Cridland has described at least two cases of post-cortical cataract in a puddler and it occurs in other occupations where extreme heat is used. Burge found that cataract could not be produced by radiation from the region of the visible spectrum or infra-red provided the temperature effect be excluded, and the work of Martin, Hess, Birch-Hirschfeld and others goes to show that ultra-violet light is without influence on the lens, and probably its capsule, in the absence of heat. As a great amount of heat is absorbed by the iris, Parsons thinks that the cataract is caused by changes in the ciliary body, with corresponding nutritive changes in the lens. So far, there is no evidence in favour of this theory.

The cataract of bottle makers is primary and posterior cortical, and is not due to gross mischief in the choroid or retina. Meyhoefer and Birch-Hirschfeld attribute it to extreme heat; Arlt to light; Leber to concentration of the aqueous by sudden evaporation from the surface of the cornea and intense sweating; Peters to the changes in the aqueous consequent on congestion of the vortex veins; and Scalinci to accumulation of carbonide acid by venous stasis through the act of blowing. There is no doubt whatever that extreme heat predisposes to premature cataract. Cataract occurring in blacksmiths and founders between 40 and 50 years of age shows a course more like ordinary senile cataract and the aetiology cannot be regarded as similar. Vogt has shown that it takes a white heat to produce infra-red radiation sufficient to penetrate the lens and produce its effect. Bottlemakers' cataract begins on the left side with discolouration of the face of the same side. It has been suggested that it cannot, owing to the protection of the aqueous, be produced by heat (Druké and Helmholtz), but Vogt has shown that it takes a much deeper layer of water to absorb the red rays than is afforded by the aqueous. According to Finson, blood and colouring matter afford the greatest obstacle to the entrance of chemical rays and these are abundantly furnished by the iris, so that if due to actinic light its occurrence in the pupillary area first is easily explained. The skin trouble is stated by the supporters of the actinic theory to be due to pigment formation in the upper strata of the skin, which according to Unna and Widmark is the result of ultra-violet rays and not heat. The mixture of sand, lime, soda and clay, according to Cramer, may be the source of this light. The truth probably lies with both, and if we look upon all cases of true cataract as a chemical change we are not justified in excluding either, as it has been shown that infra-red rays hasten hydrolysis, and actinic light is capable of modifying the lento-proteid and aiding ferment action. Its position at the posterior pole is largely a question of physics concerning the transformation of one form of energy into another—and I see no physical reason why the effect of this should not be greater the deeper we go into the lens—it is ridiculous to imagine, as has been done, that the rays are concentrated at the nodal point. The nodal point is not this by definition, but that point to which, if a ray of light be directed, it continues its course unchanged. My own feeling is that light is necessary as well as heat, but is of far less importance in these posterior-cortical cataracts, and it is not surprsing that the changes both are capable of working occur at a position in the lens, not only in keeping with our ideas of physics but of physiology too, seeing that it is here the lens is unprotected from the intra-ocular fluid.

Cataract due to traumatism may be divided into two groups: those in which the coats of the eye are involved and those, much

rarer, in which they are not. The latter can be further sub-divided according as to whether the capsule is intact or not.

The group includes Vossius' cataract, cataract following blows and contusion, and fulguration cataract. The former group has been well studied and good accounts of the histo-pathology are to be found in the textbooks. Transient contusion opacity is rare and the cases clear up in a week or so. The aetiological factor in these cases is a limited damage to the capsular epithelium, permitting imbibition of aqueous by the lens. These lesions ought to be called opacities and not cataract, and the prognosis should be guarded as many spontaneous recoveries have occurred. Concussion changes have been well studied during the late war, both anterior and posterior cortical, the former presenting many different varieties. An excellent study of posterior cortical cataract was made by Hudson some years ago. Hudson considered the changes due to distension of the lymph spaces in the lens, or to definite but usually transient changes in the lens fibres themselves.

Ormond suggests that the change giving rise to concussion posterior cortical cataract is not in the lens at all, but at the posterior surface, and is the result of fluid finding its way beneath the posterior lens capsule owing to a slight movement of the lens in the patellar fossa. Against Hudson's theory is the fact that lymph spaces in the lens have been disproved by Leber and it is a little difficult to reconcile definite alterations in the lens fibres with the transient character of the cataract. My own idea of these cases is that they owe their cause to the same set of changes that occur in the development of posterior cortical cataract, the result of disease of the uvea or deeper parts of the eye, and that they are the evidence of a reaction on the part of the lens to faulty nutritive supply. It is not difficult to imagine either a severe contusion or perforating wound producing effusion from either blood or lymph channels which would profoundly alter the composition and vital properties of the aqueous. We know that any slight alteration of the aqueous will affect the lens; the temporary character is explained by the fact that in repair the exciting cause comes to an end.

Of the anterior cortical, concussion or contusion cataract, there are several different varieties. The classical one is that first described by Vossius in 1903. Whiting has added another five varieties to the original annular variety. The interest in these types of cataract centres around the discussion which has been forthcoming regarding their cause. Vossius assumed that the ring opacities were due to the pupillary margin of the iris being pressed upon the anterior surface of the lens by the cornea, and that pigment cells were fixed thereto by fibrin, or in the case of the unpigmented grey ringed type to degeneration of the capsular epithelium at the point of contact with the pupillary border of the

iris. His theory is based on Schirmer's researches. The latter produced contusion cataract by traumatism of the capsular epithelium, which later regenerated without leaving a sign of injury. The case reported by Krusius seems to confirm this theory as he found a greyish opacity on Descemet's membrane exactly opposite the corresponding opacity in the lens. There are many difficult points to solve. Indentation of the cornea is not requisite; a small perforating injury anterior or posterior to the lens may produce it and the site of the traumatism may not be anterior to the lens. Hoeg says that a displacement of the aqueous necessary to produce a trauma which would bring the cornea and lens in contact over an area of 3 mm. diameter could not occur without rupture of the iris or cornea. He believes it is due to a sudden rise in hydraulic pressure forcing the iris against the lens. Others believe that where the pressure is applied posterior to the lens the vitreous drives the lens against the iris. Coats, on the other hand, says it is quite impossible unless the iris becomes imprisoned between the lens and the cornea as the iris will give way before the advancing lens. The occurrence of pigment granules within the Vossius ring is difficult to explain. Beresford has recently established a theory based on Bach's work on the changes following traumatism of the eye ball. According to him it is the result of a contusion with mild iridocyclitis set up with exudation from the vessels of the iris and ciliary body. The fibrin agglutinates the pupillary border to the lens capsule, which in a short space of time frees itself, leaving the fibrous ring. The pigment, both within and without the area of the opacity, he attributes to leucocytic migration from the ring itself or pigment containing leucocytes or red blood corpuscles, as blood is not infrequently present in this type of lesion.

I cannot conclude this account of the aetiology of cataract without some reference to heredity, though so little is known about it. No part of the eye exhibits in a more striking way the influence and character of heredity than the lens. Many have been content with an attempt to explain the aetiological changes which may be responsible for the formation of congenital cataract, and have done but little to explain heredity and I need not inflict you with detailed accounts. Suffice it to say that opinions are divided into two groups regarding the explanation by which congenital deformities of the lens are produced: first, those who believe the basic cause is toxic, and secondly those who believe there is an alteration in the development of the lens due to some inherent abnormality in the germ cell.

The evidence is strongly in favour of both, and it is probable that neither singly explains the cause, and that in some cases both may be active. Treacher Collins truly remarks that to attribute a condition to arrest of development offers only a partial explanation of its

aetiology, leaving the cause of the arrest to be accounted for. Variations in development can be traced with a fair degree of accuracy to a group of cells in the embryo, but an inquiry into the cause of this variation leads to a very complex situation, about which surmises only exist.

Nash thinks that as regards certain developmental defects there seems to be no reasonable doubt that, on the whole, their descent follows the system of the Mendelian dominant and that they are due to the presence of special factors, individuals not possessing these factors being unable to transmit them. The whole body may be influenced by abnormalities in the functions of glandular organs and through what Garrod has termed "inborn errors of metabolism," which latter, at any rate, appear to run in families. Cataract running in families behaves as a dominant, that is, there is something in the organism which produces cataract; there is a determiner in the germ cells for that something which causes cataract. The person who has received the determiner for cataract from one parent will have it in half of his germ cells, so that half of his children will show congenital cataract. If it could be possible by chemical or other means to rid the germ cells of the determiner for early cataract then those germ cells should produce individuals without cataract for an indefinite time. So long as people with determiner for early cataract marry they are bound to perpetuate the trait in half of their descendants. So far there is no authoritative statement on heredity, and the study of the causes underlying the facts has just begun. As Conklin says, in the absence of such knowledge it has been necessary to form theories of heredity to account for the facts, but these are only a temporary scaffold to bridge the gaps in our knowledge, and if we knew all that could be known about the germ cells and their development we should have little need for theories.

I thank you, Gentlemen, for the kind attention you have given to this lecture which, I beg you, Sir, to accept as a tribute, all too *feeble on my part I know, to the memory of* Robert Doyne, to whom we are one and all so deeply indebted.

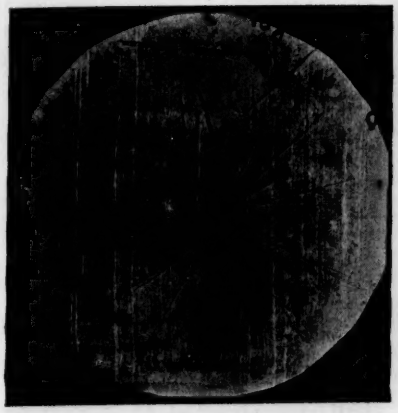


FIG. 13.

Tyrosin: from hydrolysis of the human nail.

FIG. 14.

First specimen obtained from aqueous after needling for high myopia.

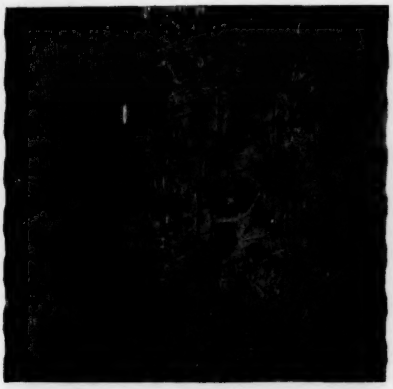


FIG. 15.

Cholesterin and tyrosin in lens in diabetic cataract.

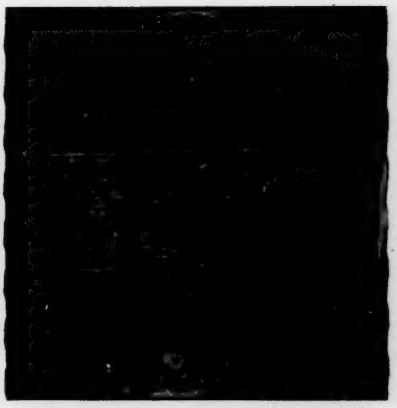


FIG. 16.

Tyrosin in lens in senile cataract.

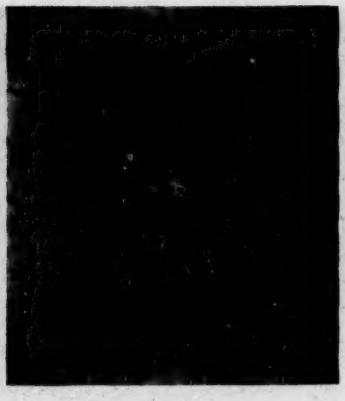


FIG. 17.
Another specimen.

FIG. 18.
Aqueous in diabetes showing tyrosin.

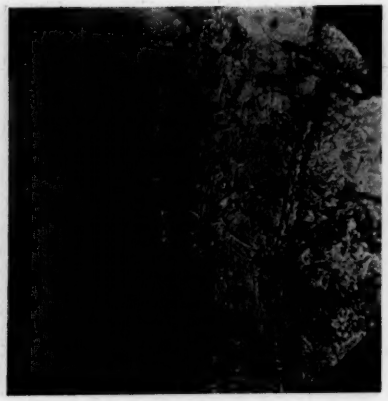


FIG. 19.
Tyrosin in lens in diabetic cataract.

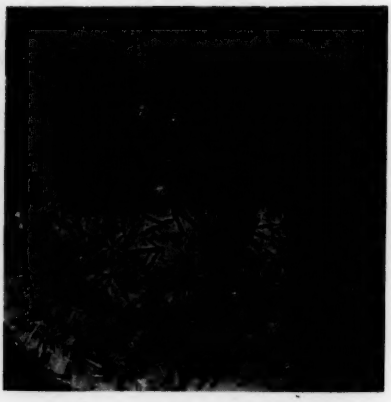


FIG. 20.
Tyrosin in lens in albuminuria (Bright's Disease.)

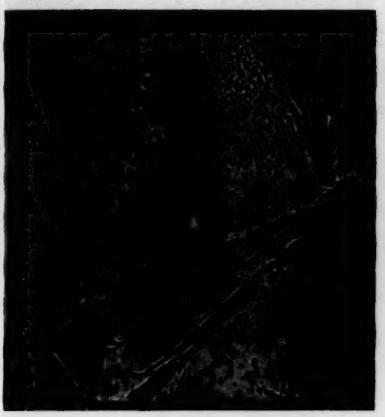


FIG. 21.

Tyrosin in lens in albuminuria (Bright's disease.)

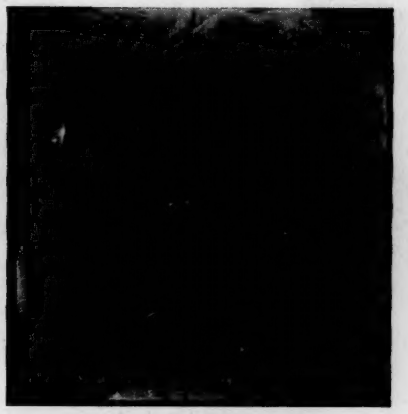


FIG. 22.

Another specimen.

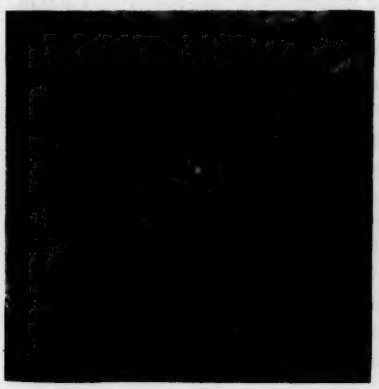


FIG. 23.

Tyrosin in aqueous in albuminuria.

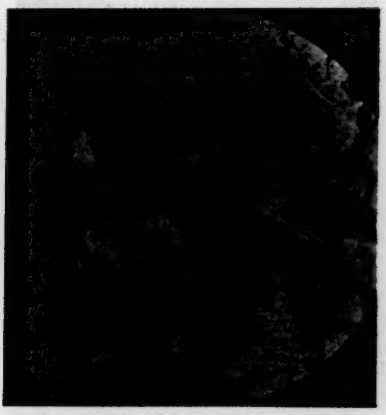


FIG. 24.

Tyrosin in lens of an ox (cataractous).

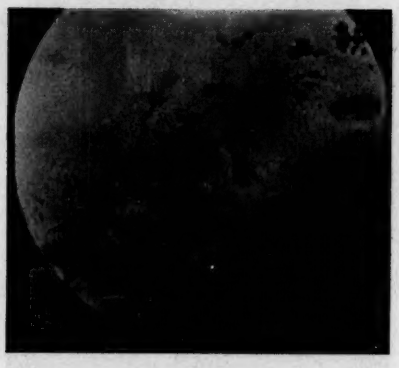


FIG. 25.

Aqueous from same eye.

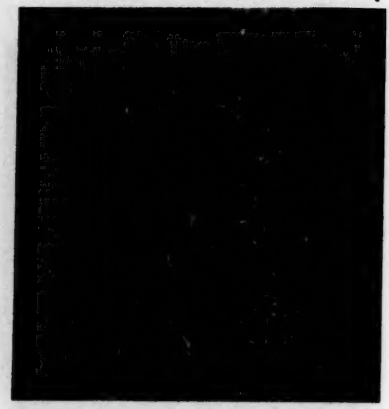
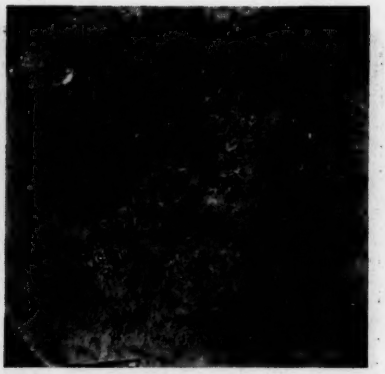
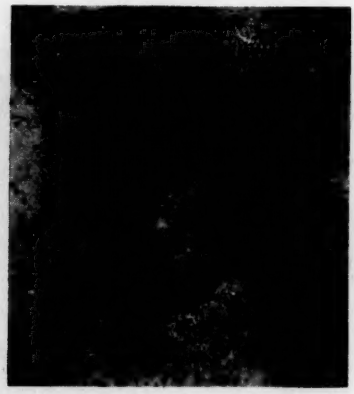


FIG. 26.

Tyrosin from lens which had lain 18 years in anterior chamber. Lens one mass of tyrosin.





FIGS. 27 and 28.

Showing method of demonstrating tyrosin amid a mass of débris and sodium choride: by breathing on the specimen the common salt, being hygroscopic, dissolves, leaving the insoluble tyrosin quite clearly defined.

(27 before, and 28 after, breathing on slide.)

A CASE OF CATARACTA ELECTRICA, EXAMINED WITH GULLSTRAND'S SLIT-LAMP

BY

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CASES of cataract, resulting from stroke by lightning or high-tension electric current, may not be so rare as generally imagined from the few cases mentioned in the medical literature of the world. This is possibly due to the fact that about 90 cited cases have been so minutely examined that nothing new could possibly be brought out. In Gullstrand's slit-lamp, however, we have a new and very efficient means of facilitating ophthalmological diagnosis. According to my knowledge only 3 cases of cataract by lightning have so far been examined in this way, this having been done by Professor Koeppe in Halle, who, with Professor Vogt in Basel, is our greatest authority on slit-lamp microscopical examinations. As my findings, however, in some respects differ from those of Professor Koeppe, the publishing of the account below may have its justification.

On September 5, 1920, a 12-year-old boy, B. L., climbed an iron mast supporting the high-tension wire from Ljabro to Drammen. About ¾ metre from the top he was short circuited by the 50,000 volts current and remained suspended on the mast in a state of paralysis. Not until 10 minutes later was he taken down unconscious. In the regular way revival exercises were applied. A little more than an hour later he was brought to Drammen Hospital, where the following state was observed :—

The boy is well built, but pale. Nothing wrong with the lungs. A subsequent examination of the urine showed neither albumen nor sugar.

The entire region from above the left upper eyelid to below the left clavicle is the location of a third degree burn. A temporary examination of the eyes, as also a later and more exact one, during his stay in hospital, showed no intraocular changes.

On the left leg, just on the outside of the knee cap, as also on the outside of the left nates, is seen a 5 × 5 centimetre round ulcer with dirty, grey, partly ragged edges, this ulcer going straight down to the bone.

The patient stayed in hospital from November 5, 1920, to February 7, 1921. A number of transplantations were performed *ad modum* Thiersch on neck, nates and leg. When leaving hospital the wounds were nicely healed. The scars were smooth,

and only a distortion of the left corner of the mouth marred his looks. The eyes were entirely normal.

During the spring his sight, especially in the left eye, decreased. He came to my office the first time on November 21, 1921. Sight in the left eye was then reduced to finger-counting at 5 metres distance, and in the right eye to 5/12. Glasses did not improve it.

Through further examination of the eyes with Gullstrand's slit-lamp and Czapski-Zeiss corneal microscope the following was found in using from 20 to 80 times magnification :—

O.S. With focal illumination the lens gives an even grey reflex. Under the rays of the slit-lamp and from 20 to 80 times magnification the hazy cortex, located immediately below the capsule, is noticed to have an appearance like a loofah sponge. In every direction thicker and thinner asbestos-looking, grey-white, fibre-trends are crossing each other. They are of different thickness and follow nowhere the direction of the normal lens-fibres. In the meshes between these fibre-trends are seen, partly, close, fine opacities of a round or polygonal shape; partly, round, vacuole-like empty cells, whose walls are made from close, grey trends. In the central part of the lens surface the opacities are fuller than in the peripheral parts. The deeper layers of the lens cannot be studied in detail owing to the opacities.

O.D. With focal illumination and direct ophthalmoscopy a few peripheral opacities of the type described by Vogt under the name of cataracta coronaria are seen in homatropin-mydriasis, both in the front and the rear cortex. Fundus is seen normal, only obscured. The delineations, however, are a little blurred, due to the lens opacities, as plainly appears under the slit-lamp. Scattered around in the lens capsule itself are a number of round, refractive cysts of different size. It remains to be said that the capsule itself and the lens layer immediately below it is the location of a fine, grey veil, especially so in the central parts of the surface, thus partly blurring the lens shagreen. At 80 times magnification this veil is seen to consist of innumerable fine threads, crossing each other in all directions, and resembling silver filigree. They do not in any place follow the run of the normal lens fibres. In this fine meshwork a few fine, greatly glittering points are located. A thin lens layer below this network was entirely homogeneous.

In the deeper layers of cortex are seen a few corkscrew-like twisted and twined ribbons partly branched and of different thickness. They have different courses and are transparent to such extent that they cannot be seen with the magnifying mirror, but only with the slit-lamp and about 80 times magnification. The most central parts of the lens—corresponding to the centre of Vogt's embryonal nucleus—are apparently quite unaffected. In

the posterior pole region of the capsule or the cortex immediately below this are a few polygonal, flat or cup-shaped stains.

The tension of the eyes is normal; 5, 5/5. The vision and the mobility are normal.

At a later examination, February 28, 1922, mainly the same observations were made. The sight, however, in the left eye was reduced to finger-counting at a distance of 2 metres, and in the right one to 5/15. The opacities in the right eye were closer together so that the fundus could be seen in reversed picture only with difficulty. While the anterior chambers at the first examination were of a normal depth, they were now shallow, especially in the right eye. Sight was normal. The urine contained neither albumen nor sugar.

The first account of cataracta electrica was published by Th. Saemisch in 1864 in *Klinische Monatsblätter f. Augenheilkunde*. A one-sided, rapidly increasing, grey cataract developed in the case of an 18-year-old girl 5 months after she had been struck by lightning. Leber could, in 1882, gather 6 cases from the literature of the world, where cataract developed from half a year to one year and a half after each person had been struck by lightning. A number of additional cases were now published, quickly succeeding the above mentioned. It was also shown that a powerful electrical discharge, striking the head, might develop identical results. In Norway a similar case has been published by Dr. Scheen (1906) in "Tidsskrift for den norske Laegeforening," under the heading: "How powerful an electric current can a person stand without being killed?" In this case the person in question had been struck by about 6,000 volts in the head, which became the seat of a severe burn, as big as a hand, and penetrating down to the bone. About 4 months later a right-sided increasing cataract commenced developing, maturing after 2 years. This was examined by Dr. Holth, who points out in his description that the cataract, before maturing, formed an irregular, grey lattice-work of twined and branched ribbons, both in the front and the rear cortex, more, however, in the latter, and never following the normal structure of the lens.

The first observer to deal experimentally with eye injuries caused by electricity, was v. Hess. Experimenting on rabbits and cats, he let their orbital regions be struck by sparks from big Leyden jars. Subsequently a high degree of miosis and iris anaemia was developed; later on, sometimes merely after half an hour to a couple of hours, streak chemosis and opacity of corneal-epithelium would develop, and the anterior chamber would be filled with exudation as hyperaemia of iris and ciliary bodies appeared. After 2 to 4 hours he could localize fine, grey opacities in the equatorial regions of the lens. These might

disappear again or increase, so that the lens during 1½ to 4 weeks might acquire the characteristics of a cataract. The first microscopical change detected by v. Hess, even as soon as ¼ to ½ hour after the eye had been injured, was an extensive dying off of the epithelium on the front capsule, similar to the one appearing after the experimental naphthalene—and massage—cataract. A series of minute works has been done by different persons in order to find out how and in what way this change of the epithelium and fibres of the lens occurs after the electrical shock, without, however, it being settled, as yet. That the ciliary body in one way or another has to do with it would seem certain, according to investigations by v. Hess, Knies, Silex, Vossius, Hamburger, and recently Löwenstein.

If, according to this summary, we look at the above account, we immediately notice the peculiar shape of the opacities. It would seem, drawing conclusions from my case, as also from a number of others referred to, that *the characteristics of the opacities with cataracta electrica are the confusion of corkscrew-shaped threads and laces, crossing each other in all directions, without following the regular run of the lens fibres.* This, which is even seen using ordinary focal light, is beautifully distinct when seen under Gullstrand's slit-lamp. These ribbons may be of very different thickness in more developed cases of cataract. In the first stage—as in the right eye in our case—the threads had a veil-like appearance, located immediately below the capsule and partly blurring the lens-shagreen. Also in the deeper layers they formed broader ribbons, extremely twined and interlaced. In the mesh openings between these ribbons and silver glistening threads, fine and very glistening points were located. Vogt holds that these are cholesterin, while Koeppe does not want to express any opinion on this point. I am sorry to state that I have not had an opportunity by chemical analysis after operation to add to the solution of this question.

Further, it is to be seen that with cataracta electrica innumerable refractive arch-shaped cysts in the anterior capsule respectively underlying the capsular epithelium are formed. I have seen a similar picture only with glaucomatous and traumatic cataract. Koeppe states that it is also seen with complicated cataract. These peculiar cysts, giving the surface of the lens the very same appearance as that seen under the rays of the slit-lamp in vesiculosa externa must be supposed to result from dead epithelium, forming a liquid albuminous mass. I refer to the description given by v. Hess about the histological type of lightning cataract in rabbits and cats in Graefe-Saemisch *Handbuch d. Ges. Ophthalm.*, third edition, 1911. This histological type, developed experimentally, is shown "*in vivo*" through the slit-lamp.

In the cases described by Koeppe, as well as in mine, there was a homogeneous layer below the most superficial capsular and cortical opacities, which would seem to indicate that a lamellar cup-shaped separation between the most superficial cortical layers had taken place. The described opacities in the rear layers must be construed in the same way.

In one point the slit-lamp findings for the right eye differ from those published by Koeppe. In our case a few peripheral opacities resembling bicuspid teeth were seen in the front as well as the rear cortex, subcapsularly located in the place characteristic of Vogt's coronal cataract bordering on the extreme and the middle third of the lens radius. As the coronal cataract of Vogt very seldom is seen before the age of puberty, I have only found typical Vogt's cataract in 9 of 177 examined cases below 15 years, not yet having reached the age of puberty—referring to my work on this subject, based on about 5,000 examined eyes, *Kliniske Linsestudier,* published in Norwegian 1920, and reviewed in this journal by Dr. W. G. Sym, pages 178-181 (1921). Of these 9 cases, only 2 were below 10 years, and 7 from 12 to 13½ years. The possibility is, therefore, not excluded that an electric shock may cause a coronal cataract, even if no single case may serve as proof. Later, slit-lamp examinations will establish this.

Our present case has been unable to render any further assistance in determining what physical-chemical changes are taking place through the application of electric current. In this case there was a high voltage—about 50,000 volts. In one of Löwenstein's 5 cases it amounted to merely 16,000 volts. According to Komoto and Terrien, a discharge of 550 volts is sufficient to cause cataracta electrica in persons so disposed.

Neither 16,000 nor 50,000 volts can have passed straight through the persons hurt, as, according to Scheen, the current used for electrocution in U.S.A. is only a direct shock of 6,000 volts. The insulating air column separating the wire and the victim is of great importance. It is further reasonable to suppose that a person's individual ability or lack of ability to withstand electrical shocks plays an important part in the different cases.

TONOMETRY

BY

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HJALMAR SCHIÖTZ described his tonometer in 1905. His first publication was followed by quite a number of essays—of both practical and theoretical interest—from various countries. Most of them are built on very few examinations though. The only one of any importance is B. Cridland's in 1917, founded on 1001 examinations. But even this number is much too small to decide such an important question as this: "Are the limits for normal intra-ocular pressure given by Schiötz really the right ones?" There have, for years, been those who would have especially the upper limit higher than that given by the inventor of the instrument.

In order to try and solve this problem I have tonometrically measured 1,095 persons with 2,186 eyes between them. Every one of them was examined with Gullstrand's slit-lamp and the binocular microscope of Czapski-Zeiss in maximal homatropin-cocain mydriasis as well as being also examined with the ophthalmoscope in the ordinary way.

I have published my results in the *Festschrift für Ernst Fuchs*, pages 221-242 (*Arch. f. Ophthal.*, Tome 105, June, 1921). In this I have mentioned the most important publications about tonometry issued after 1905. The following is a recapitulation of the essentials from my results:—

All examinations are made with the lower weight of the instrument =5.5. In 1915 I published a paper in the *Norsk Magazin for Laegevidenskaben* recording the influence of different weights upon accurate results in tonometry. I soon found, like others, for instance Schiötz, that the index gave a greater oscillation with heavier weights than with that of 5.5, probably caused by an act of massage. The examined were all lying on a couch. Care was always taken in the accurate application of the footplate of the instrument on the cornea, as Schiötz and Priestley Smith have advised it should be. Two measurements were always taken in succession. Were they not alike the average was taken. *In that way we can read with an accuracy of one decimal.* Even with such a precise instrument as the Schiötz tonometer we cannot read the oscillation of the index with greater accuracy than 0.5 mm., viz., 1 decimal. *When I have used 3 decimals in my tables it is only to be able to compare the tables of the different authors.* In my above-mentioned German work on this subject the lowest action of the index is always notified, viz., the highest intra-ocular pressure. With action 3, I mean both 3 and 3+, with 3.5, 3.5 and 4 —.

The persons examined can be divided into two groups: the first group counts 1,128 eyes, which, in every respect were completely normal in 567 individuals between 10 and 87½ years. The second one counts 1,052 eyes in 526 persons 15 to 80 years old. In these I have found cataract of some kind or other. In most cases the opacity was of the kind which Vogt has described as "koronar-cataract." These opacities I have described in my book *Kliniske Linsestudier,* which was kindly abstracted in this journal by Dr. Sym, 1921, pages 177-181. This form of cataract is, in my opinion, not to be regarded as a malady, but only as a physiological peculiarity—just as wrinkles, baldness and grizzling of the hair in old age. This cataract must not be mistaken for another kind which is known to develop after the forty-fifth year of age in an increasing frequency. This is derived from the so-called "water-slits" ("*wasserspalten,*" after Becker and v. Hess, who first described them). This cataract is the ordinary senile form. The koronar-cataract and the "water-slit" cataract often melt together in old age. This koronar-cataract is not to be mistaken for the so-called "cataracta coerulea punctata," which we find in about 5 per cent. of all normal lenses examined with the slit-lamp. These small spots, scattered in all layers of the cortex, are congenital and probably not inclined to increase.

The koronar-cataract is of a very typical appearance. To begin with, it is located in an intermediate zone between the outer and the middle third part of the lens radius. It is always separated from the lens capsule by clear cortex. In its initial state, it has radially placed club palisade or lancet-shaped opacities, which at first are isolated, but which later on are inclined to coalesce. They are always lying parallel to the lens fibres and the surface of the "nucleus lentis." They may be so thin that they may be overlooked with the magnifying mirror. As shown in Table II, there is practically no difference, to speak of, between the tension of the group of eyes with opacities and that without. In my opinion, both the onset and period of cessation of sexual life must be regarded as having a slight but distinct influence on the development of cataract, not only the senile, but also the koronar. That the cessation of sexual life must have at least something to do with the development of cataract, I based on the fact that out of 387 women with cataract (examined by me), 48 per cent. had passed through 1 to 15 pregnancies and 13 per cent. had had one or more miscarriages, while out of all women with clear lenses (examined by me), only 15 per cent. had borne 1 to 13 children, and only 3 per cent. had had miscarriages. We know from other observations (Chvostek and Kehrer) that when the ovarian function is in abeyance a rise of the calcium and cholesterin content of the blood will follow. And we also know that the

above-mentioned two substances may possibly have something to do with the aetiology of the cataract (Laqueur). The percentage of cataract found in my women patients under 50 years of age has also been considerably higher than among men examined by me. After this age the curves lie completely parallel. I also have observed how the elements of the koronar-cataract seem to take a rapid growth just about the time of the climacteric. I therefore feel inclined to believe that a frequent suspension of the ovarian function such as in pregnancy and lactation may have some influence on the development of the cataract. Dr. Gallus, in Bonn, has recently published a paper—independent of my results on this subject—in which he comes to almost the same conclusion.

TABLE I.—COMPLETELY CLEAR LENSES.

Year	Number	O, S.	Number	O. D.	Average Tension
10 ...	17	4.588	17	4.588	4.588
11—20 ...	117	4.509	117	4.468	4.489
21—30 ...	111	4.354	111	4.342	4.348
31—40 ...	106	4.566	106	4.955	4.761
41—50 ...	96	4.065	88	4.138	4.102
51—60 ...	82	4.091	82	4.134	4.112
61—70 ...	37	4.122	37	4.216	4.169
71—80 ...	4	5.250	4	5.125	5.188
	570	4.443	572	4.483	4.470

TABLE II.—MORE OR LESS DEVELOPED CATARACT.

Year	Number	O, S.	Number	O. D.	Average Tension
15—20 ...	24	4.625	24	4.633	4.629
21—30 ...	58	4.327	57	4.438	4.388
31—40 ...	37	4.433	38	4.538	4.486
41—50 ...	106	4.495	105	4.519	4.507
51—60 ...	150	4.380	150	4.420	4.400
61—70 ...	88	4.261	88	4.386	4.324
71—80 ...	56	4.848	57	4.746	4.797
81—87½ ...	8	5.312	8	5.437	5.375
	527	4.585	527	4.638	4.863

We see from the tables that the lower limit which Schiötz has fixed =6 with 5.5, cannot be kept. This he has said himself in one of his later publications. We may find an oscillation of 7 to 8, and even more, both in individuals with clear lenses and in those with cataract more or less developed, although we cannot find any pathological alteration of the eye. *Therefore, before claiming any fixed lower limit, we ought to make at least* 10,000

tonometrical measures on normal eyes, and by the same examiner.

An action of 7 to 8, or more, with a weight of 5.5, does not, in young and healthy people at least, indicate a pathological hypotony. We must confess that at the present moment we do not know the lower limit, yet I am bound to say that when I have found such a low pressure in elderly persons I very often have seen more or less developed " chorio-retintitis." Of 24 individuals with this hypotony, and more than 50 years of age, I have found " chorioiditis or chorio-retinitis " in 23 of them.

Still more difficult is it to determine if an oscillaton of < 3 with weight 5.5 is pathological or not if we otherwise cannot detect any sign of pathological alteration which may indicate glaucoma, such as, for instance, the sign of Bjerrum or that of Seidel. The latter, the wing-shaped enlargement of the blind spot, may be a very important symptom of " glaucoma chronicum incipiens," when far developed. But one must always be suspicious, even if the " wings " are small. Holth made in 1895 a very exact study of the so-called " vessel scotoma." He used the method of Bjerrum. Both in looking for glaucoma and in seeking those peculiar concentrical ring-scotomata, which Wettendorfer has mentioned in describing some cases of high myopia, and which I never could find, although I, both in my private practice and especially in England and Germany, have examined a great number of eyes with a high degree of myopia and always have been on the look-out for this symptom. But what both Holth and I often have seen is this: that by moving the small Bjerrum object very slowly, small wing-shaped enlargements on the upper and lower border of Mariotte's blind-spot appear, where no other sign of glaucoma is to be seen. The reason is, in the opinion of Holth, that the retina is tired out by gazing at this small object. He has proposed the name " staring-blindness."

When we read the literature about tonometry, we notice that very few have reported cases with the tension < 3, with weight 5.5 in normal eyes. Cridland personally has told me that he has seen a few with pressure 2, with 5.5, for years not presenting any sign of glaucoma, but who by and by turned out to be glaucomatous. *In all persons examined by me I have only found 6 normal eyes, where the intra-ocular tension was less than 3, with the before-mentioned weight.* In only one of these cases have I found the pressure 2; the rest show 2.5. They were all people between 21 and 28 years of age. Though I could not find any glaucomatous symptom, I think they all must be regarded as suspicious, and ought to be kept under observation for years. This opinion of mine is based on the fact that I have found only 68 persons out of all those which I had the opportunity to use the

tonometer who had an intra-ocular tension of 3 with the lower weight. *But I certainly do not mean that the oscillation 3 or less, with 5.5 indicates operation when no other sign of glaucoma is present.*

It seems that the upper limit 3 with 5.5, which Schiötz has proposed for intra-ocular tension threshold must be kept up. We also ought to make notes of results found with the tonometer in the manner in which the inventor of the instrument has proposed:—In a fraction to write down the weight used as numerator and the found oscillation as denominator. This way to state the result ought to be international. We ought not to change it into mm. Hg., because Schiötz and Priestley Smith, by numerous experiments, have shown that the fraction gives us the average of a series of different Hg. measures.

I have made use of both the old and the new means of Schiötz in order to change my results into mm. Hg. to compare them with those of Cridland. Like him, I have arranged my persons in decades (Table III). This shows that my result differs a little from Cridland's. My mean figure is either 17,698 with the old average of Schiötz, or 23,836 with his new one, while Cridland's is 20.06. If we, instead of the figure of Schiötz, take that of Priestley Smith, they are practically alike: 21.16 against 20.06.

Hamburger, in Berlin, who, in the number of *Klinische Monatsblätter für Augenheilkunde* of December, 1921, has published a paper about the intra-ocular pressure, has found exactly the same thing. He specially points out that alterations of the uvea are usually followed by a decrease of the intra-ocular pressure.

TABLE III.

Own Examinations.						*Cridland's Examinations.*		
Year	Number			Average Oscillation recalculated into mm. Hg.		Year	Number	Average Oscillation recalculated into mm. Hg.
	Individuals	Eyes		By Schiötz old means	By Schiötz new means			
10	17	34	4.588	17.766	23.884	1—10	12	23.75
11—20	141	282	4.559	17.925	24.087	11—20	259	20.69
21—30	169	337	4.368	18.976	25.424	21—30	224	19,30
31—40	144	287	4.624	17.568	23.632	31—40	159	19.13
41—50	198	395	4.294	19.383	25.942	41—50	180	19.26
51—60	232	464	4.256	19.592	26.208	51—60	113	21.47
61—70	125	250	4.493	18.284	24.549	61—88	54	19.59
71—80	61	121	4.993	15.539	21.049		1001	20.06
81—87½	8	16	5.313	14.248	19.748			= 4.17
	1095	2186	4.488	17.698	23.836			

I have made a series of measurements on 8 persons at different times of the day. They were all young people, aged 21 to 28 years, and with normal eyes. *The variations were of very small importance in normal eyes compared to the glaucomatous ones,* in which they often could be very considerable.

There proved to be *no difference in the pressure whether the eyes were blue or brown in colour.* Variation of tension may differ greatly in the 2 eyes of one and the same individual.

I have examined the tension under the power of different drugs on a number of normal persons' eyes. I have made use of holocain, homatropin, eserin, pilocarpin, morphia and cocain. At first I only noted the above-mentioned 8 cases. Later on I have continued these, in my opinion, rather important observations. Not having intended to publish them, I have no exact idea of the number of the readings.

Holocain of 2 per cent. solution seems to have no influence on the intra-ocular tension, but not seldom I could observe, under the corneal microscope and the light focus of the slit-lamp, round or polygonal dry spots, such as Koeppe has described. They were superficially located under the ephithelium of the cornea and disappeared completely after a few (maximum 6) hours. These are surely caused by the drying out of the superficial layers of the cornea as in the case with the transient stains and opacities, which we can see after instillations of cocain.

Homatropin 1 per cent. solution had no effect on the tension of the normal eye.

Cocain hydrochloride 2 per cent. solution had no influence, but instilled with 5 per cent. the tension sunk in all the examined persons.

Pilocarpin hydrochloride 2 per cent. solution and salicylate of eserin ½ per cent. solution caused in every case a decrease of tension. In some persons it might happen that the pressure sunk more (3) of the dividing lines of the tonometer.

Three persons who, from other reasons, had got morphia injected subcutaneously were examined with the tonometer. I could not find any alteration of tension even half an hour after an injection of the usual dose: 1 to 2 centigrams. Morphia was otherwise not tried.

Lastly, I must add that I have had the opportunity of measuring the tension of 2 patients attacked by syncope. Their eyes were normal. The intra-ocular presure was found to be 14 and 10, with 5.5, while they were lying unconscious. Under normal circumstances it was found to be 3.5, and 5 with the same weight.

Dr. McLean's instrument I have never had the opportunity to use. I believe that the higher weight of it will, in small pathological differences, give less exact clinical results than the Schiötz instrument. What I have above mentioned about an act of massage surely will produce its effect.

ONYX OF LONG DURATION

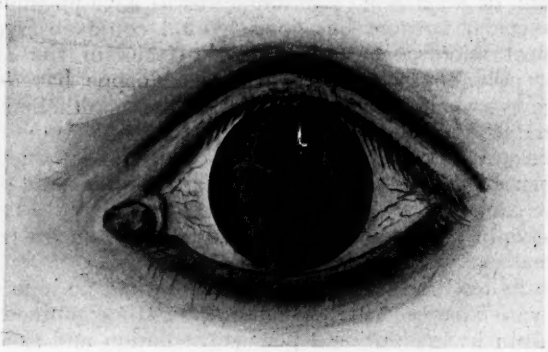
BY

D. J. WOOD

CAPE TOWN

Onyx of long duration. Miss C. S., aged 26, came to me asking whether I could remove a white mark from her left eye. On casual inspection it looked like a round nebula with a yellow opacity at the lower part. She asserted that it had been there ever since she had measles twenty years ago.

On careful examination one found a round cavity like a double watch glass containing at the lower part some thickish pus which,



on pressure, changed its shape. The cavity had a clearly defined circular margin and extended from the corneal margin to the inner third of the pupil. The eye was perfectly quiet, there had never been pain, nor was patient conscious that any change had ever occurred. The cavity extended back to Descemet's membrane, and the iris was irregular on its surface behind it. The fundus was visible through the clear part of the cornea, and vision was 6/36.

After watching for some time and vainly trying to photograph it, I took her into hospital and incised the cavity with a discission needle. With a little coaxing and irrigation all the pus was removed, and the eye looked nearly normal. The outline of the cavity remained clearly visible on careful inspection, but was no longer conspicuous. I am not aware of any case where pus has remained in the cornea for so long a period as this.

INTRA-OCULAR CYSTICERCUS

BY

D. J. WOOD

CAPE TOWN

THIS, like hydatid cysts of the orbit, is much more common in South Africa than in England. Six cases have come through my hands. The first two were in the vitreous, and one of these was shown to several ophthalmic surgeons in London for me by the late Mr. Nettleship. The second was sketched by Mr. Donald Gunn, and in both of these the head and suckers could be clearly seen. The third case, a very early one with the parasite just over the yellow spot, and only a little larger than the width of the disc, came once only and was lost sight of. The fourth, an excised eye,

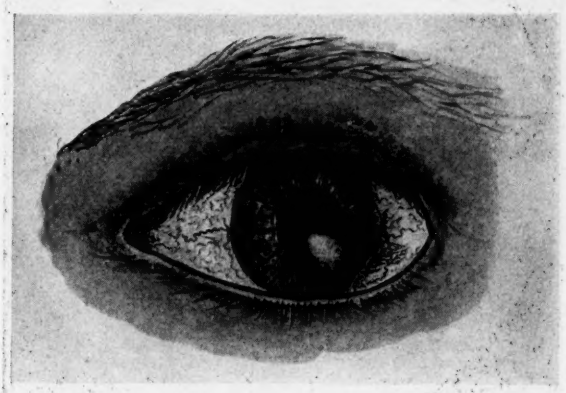


FIG. 1.

is in the Royal London Ophthalmic Hospital museum. A few remarks on the other two cases may be interesting.

1. The patient was a druggist and in a small way a farmer, and came to me for pain in the left eye of three weeks' duration, much more severe for four days. On the lower outer part of the iris there was a very definite cystic body, white in the centre and projecting into the pupil. It was fixed to the iris by numerous fine threads like spider-web or cotton wool. There was severe iritis and much pain and photophobia. Atropin produced no effect, and after a few days it was clear that the cyst was larger. No movements could be detected, but observation was difficult owing to the great photophobia. Under an anaesthetic I tried to remove the cyst with its bit of iris, but at the first touch of the

forceps the cyst ruptured into the anterior chamber. Fragments were removed, but the threads were elastic and held to the iris. No hooklets were found in the débris, but the threads were examined and appeared to be hyaline, with cells at intervals. The sketch gives a fair idea of the appearance, and the micro-photograph of the threads. There was immediate relief from pain, but the pupil was largely occluded by lymph when the patient left.

2. The remaining case I saw in 1903. Patient (R. H. T.) came with a history of failure of vision in the left eye for three

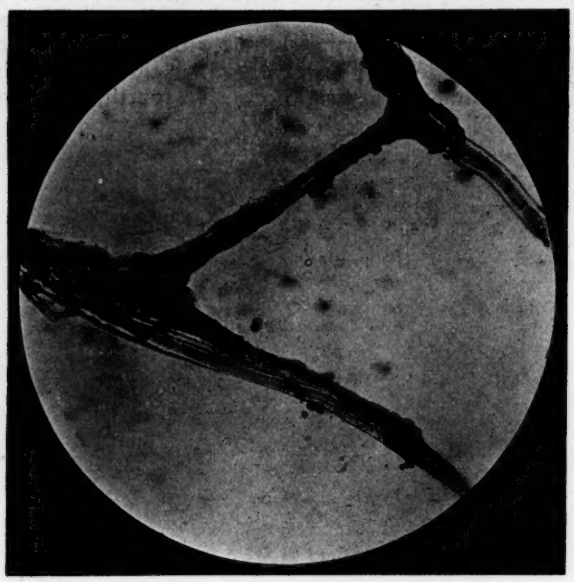


FIG. 2.

months beginning with flashes of light. The right had been failing for three days. The left eye had still 6/12, but the right had only eccentric vision. No causal history could be obtained.

There was to be seen in the left eye a streak of serpiginous disturbance of the choroid, passing upwards from the disc. No visible detachment, but much vitreous dust. In the right eye were several recent spots of choroiditis, and on the inner side a large detachment. I formed no opinion of the nature of the case, and the patient disappeared for over two months. When I saw him again the left eye was blind from extensive detachment. The light helped him to grope about. He was put to bed and after

two weeks, performed paracentesis in each eye, and removed from beneath the retinae a fair amount of straw-coloured fluid. The right eye improved and one could see the puncture mark with the ophthalmoscope. The left remained blind, with complete detachment. About this time he developed a febrile illness, and was taken into hospital. It was not typical of anything, and was supposed to be a form of typhoid. After this he went home to England, and I heard to my surprise that both eyes had been excised for pain, one at Moorfields, the other at Guy's Hospital, and the remains of a cysticercus found. The attack of fever was probably a cysticercus fever, but from first to last there was no sign suggestive of cysticercus, though, of course, the bilateral affection would tend to put one off the track.

I have since found the report made on this case at Moorfields Hospital (p. 514, No. 6814 I.P.), which throws much doubt on the cysticercus theory. There had been severe choroido-retinitis, with organization of the subretinal exudate. There is a large space near the papilla, and one near the ora serrata which are filled with fibrin, and may have been cysticercus cysts, but there is nothing diagnostic about them. The retina is partly detached, but is mainly adherent to the surface of the newly-formed tissue.

I have not seen the report on the other eye.

ANNOTATION

LIGHTING IN FACTORIES AND WORKSHOPS

THE Departmental Committee on lighting in factories and workshops have now issued their third report. We greatly regret to note that owing to the urgent need for economy the present report is the final one, and we share the Committee's hope that further work on this most important subject may be resumed at a later date. As the Committee have included in this final report the recommendations made in the two previous reports, we have decided, in view of the great importance of the subject, to publish the part of the report embodying these recommendations in full. In addition to this part of the report, there are five valuable appendices which should prove of great assistance in pointing out to future workers on the subject fruitful lines of experiment. The first appendix gives a classification of the nature of the work in thirty-two different industries as regards " fine work " and " very fine work." The second appendix deals with observations on artificial light in spinning and weaving, and incidental processes

in the cotton, woollen and worsted industries. This includes a set of diagrams showing graphically to what extent any given illumination is used for each process investigated, and also a number of analytical tables of the results obtained. The third appendix gives a summary of foreign lighting codes, and also a table of the recommendations of the American Illuminating Engineering Society for good lighting practice both general and on the work. These will be found to be considerably higher than the statutory minima for the respective types of work. The fourth appendix gives details of experiments to determine the relative efficiency of artificial light, daylight, and mixed light, carried out in the factory lighting experimental room at the National Physical Laboratory. The fifth and last appendix describes an experimental apparatus for the lighting of glass-bevelling shops, an industry in which complaints have been made as to lighting conditions.

Although much work still remains to be done on this important subject, the present report is a considerable advance on all previous work, and it is to be hoped that legislative measures will pay due attention to the recommendations that accompany it. The report itself should certainly be in the hands of all those who have the management of factories.

REPORT OF THE DEPARTMENTAL (HOME OFFICE) COMMITTEE ON LIGHTING IN FACTORIES AND WORKSHOPS—THIRD REPORT

FORMER RECOMMENDATIONS.

As our inquiries, owing to the urgent need for economy, are for the present concluded, we think it advisable to repeat here the recommendations we have already made in previous reports.

FIRST REPORT.

In our First Report we recommended that,

1. There should be a statutory provision—
   (*a*) requiring adequate and suitable lighting in general terms in every part of a factory or workshop, and
   (*b*) giving power to the Secretary of State to make Orders defining adequate and suitable illumination for factories and workshops or for any parts thereof or for any processes carried on therein.

We also considered the minimum intensity of illumination desirable for the sake of general convenience and safety in parts of the workshops where work is normally carried on, and in yards,

passages and open spaces along which people are ordinarily liable to pass, and made the following recommendations:—

2. " Over the ' working areas ' of workrooms the illumination measured on a horizontal plane at floor level shall be not less than 0.25 foot-candle, without prejudice to the illumination required for the work itself."
3. " In all parts of iron foundries in which work is carried on, or over which any person is ordinarily liable to pass, the illumination measured on a horizontal plane at floor level shall be not less than 0.4 foot-candle."
4. " In all parts of factories and workshops (not included under recommendation 2) over which persons employed are liable to pass, the illumination measured on a horizontal plane at floor level shall be not less than 0.1 foot-candle."
5. " In all open places in which persons are employed during the period between one hour after sunset and one hour before sunrise, and in any dangerous parts of the regular road or way over a yard or other space forming the approach to any place of work, the illumination on a horizontal plane at ground level shall be not less than 0.25 foot-candle."

In exceptional circumstances hardship may be caused by enforcement of the above requirements and, to meet such cases, we recommend that,

6. " There shall be power for the Department to allow exemption in individual cases."

Finally, we recommended that,

7. " All external windows of every workroom shall be kept clean, on both the inner and outer surfaces, but in order to meet exceptional cases as below, there should be power to substitute for the above a definite and binding scheme for cleaning the windows at reasonable fixed intervals, where, for example—
   (*a*) the windows, or some of them (e.g., roof windows), are not readily accessible; or
   (*b*) the total surface of external windows is exceptionally large in relation to the floor space; or
   (*c*) the conditions of work are such that compliance with the ordinary requirement is, in consequence of the nature of the work, impossible."

Finally, our First Report contained several appendices in which the data obtained by us were summarized.

SECOND REPORT.

In view of part (*b*) of recommendation 1, we proceeded, on the resumption of our work in November, 1920, to consider the provisions which should be embodied in any Orders which may

eventually be made and, in our Second Report, we recommended the following provisions as necessary for ensuring suitability in artificial lighting :—

(A) " Every light source (except one of low brightness*) within a distance of 100 feet from any person employed shall be so shaded that no part of the filament, mantle or flame is distinguishable through the shade, unless it be so placed that the angle between the line from the eye to an unshaded part of a source and a horizontal plane is not less than 20°, or in the case of any person employed at a distance of 6 feet or less from the source, not less than 30°."

(B) " Adequate means shall be taken, either by suitable placing or screening of the light sources, or by some other effective method, to prevent direct deflection of the light from a smooth or polished surface into the eyes of the worker."

(C) " Adequate means shall be taken to prevent the formation of shadows which interfere with the safety or efficiency of any person employed."

(D) " No light sources which flicker or undergo abrupt changes of candle-power in such manner as to interfere with the safety or efficiency of any person employed shall be used for the illumination of a factory or workshop."

We think that all new installations should conform to these requirements, but we recommended—

(E) " That, as regards existing installations, a reasonable time limit should be given before the above requirements become operative."

ADEQUACY OF LIGHTING.

Our Second Report having dealt with that part of Recommendation 1 (*b*) of our First Report which concerns the suitability of lighting, we were left with the important problem of adequacy—how best to secure the " adequate lighting " which we have already recommended should be required by Statute and defined

* By " low brightness " is meant an intrinsic brilliance of not more than five candles per square inch.†

† March, 1922. We now desire to add the following note :—

" Examples of sources of low brightness are a batswing burner, a paraffin flame, etc., and sources of about the same brightness as these are not regarded as coming within the scope of this recommendation.

" It should be remembered that the covering of a brilliant source by a very small shade (such as a silica cup covering a high pressure gas mantle, or a small opal globe surrounding a high-power electric source) may give this shade or globe a brightness three or four times as great as the five candles per square inch, so that it may cause considerable glare and should consequently be treated as a source of light in itself."

by Order of the Secretary of State for different industrial processes.

It is clearly impossible to specify any one standard of illumination of general application. Lighting requirements vary so much that every process in each industry must be taken into consideration.

Nevertheless we thought it possible that most of the chief processes might be classified in a limited number of groups according to the illumination needed, and thus the whole investigation brought within manageable dimensions.

In dealing with the question of adequacy two alternative courses of procedure present themselves:—

(1) Definite minima may be laid down, below which illumination on any part of the working plane must not fall.

(2) Standards of illumination may be specified as recommended practice, to serve as guides in determining whether lighting is adequate.

Such standards would not be legal minima, but would conform to the best present practice, and would represent figures which may reasonably be expected for the general standard of illumination over the working plane. Till our investigation had made considerable progress, it was impossible to decide which of these alternatives to recommend.

Before deciding on minima such as those referred to in (1), it was necessary to obtain information as to the illumination required for typical processes.

Many data illustrating the existing practice before the war will be found in our First Report, but we felt some doubt as to how far changes had been introduced since that date, especially in textile mills. We therefore arranged for further measurements to be made in such mills. These measurements are tabulated and analysed in Appendix II to this Report.

Besides our own data for factories in the United Kingdom, a certain amount of information is now available about the conditions in other countries. We have examined the Codes of industrial lighting which recently have been given statutory force in many of the United States of America, and the scales recommended by the German Society of Illuminating Engineers. These are set forth in Appendix III.

With our own measurements and these foreign scales before us, we proceeded, with the assistance of the Factory Department, and in particular of Mr. John Jackson, O.B.E., H.M. Deputy Chief Inspector of Factories, to arrange in two groups the chief processes in the main industries of the country, which require specially good lighting. (*See* Appendix I.)

In the first group we placed processes involving what we may call "fine work," and in the second group we put processes involving "very fine" work. While we do not claim that the

schedules we have prepared are complete, they cover a wide range, and we believe them to be substantially correct. We hope that they may be found useful not only by the Home Office, but also by factory occupiers and by those engaged in designing lighting installations.

Our next step was to submit these schedules, with preliminary suggestions for numerical standards of illumination both for them and also for the excluded processes (requiring only moderate illumination), to representatives of the textile, clothing and engineering industries. Our Classification Sub-Committee met representatives of employers and operatives in the cotton and silk industries in Manchester, and of the wool industry in Leeds. Measurements of illumination were made in several mills in the presence of the representatives of the cotton industry, and the representatives of the wool industry undertook to compare our suggestions with measurements made on their own behalf.

The opinions of the representatives of these industries and our own investigations have led us to the conclusion that we cannot at present recommend the enforcement of legal minima of illumination for industrial processes.

Requirements must be kept low if they are to be enforced as legal minima. On a large working plane—such, for instance, as a broad loom—illumination must vary considerably, and points here and there may fall below a good standard without much harm, if the main area of work is well lit. On the other hand, the general standard of lighting in progressive factories has risen and is rising. It would be unfortunate if a too rigid requirement, which, as we have said, must be put low, tended to stereotype existing conditions, or even to give an excuse for depressing general practice.

The problem is complex. Extensive investigations are necessary before it will be possible to recommend definite minima of illumination to be enforced by legislation. These, owing to the need for economy, we are unable to carry out.

We have accordingly accepted the alternative of specifying standards of illumination as " recommended practice " for " fine " and " very fine " work, rather than definite and legal minima. We now submit the following recommendations :—

(A) In giving effect to the procedure indicated in our First Report for defining adequate illumination for processes carried on in factories and workshops, definite legal minima shall not at present be imposed, but a specification of minimum standards of illumination as " recommended practice " for different groups of processes shall be issued.

(B) The Schedules A and B given in Appendix I of this Report shall be taken as the basis of this specification; the standard of illumination for processes grouped in Schedule A shall not fall below three foot-candles, and for processes grouped in Schedule B shall not fall below five foot-candles, both schedules and standards being subject to amendment from time to time.

These schedules cover " fine " and " very fine " work.

While with our present information we are unable to frame definite recommendations as regards processes which need only moderate illumination, it must be remembered that, if the recommendations of our First Report are adopted, the illumination at floor level over the working areas of workrooms cannot fall below 0.25 foot-candle. This will give a considerably higher minimum illumination over the working plane, but we are well aware that this will be insufficient for many of the processes excluded from Schedules A and B.

MIXED LIGHTING.

The subject of mixed lighting (partly artificial light and partly daylight) was brought to our notice by witnesses in giving evidence before the presentation of our First Report, and there appears to be a general impression that it is less satisfactory for certain kinds of work than either daylight or artificial light alone. When working on coloured material, operatives might naturally find difficulties if the two sources were different in quality of light.

We therefore thought it desirable to initiate some experiments in order to obtain definite information on the subject of mixed lighting.

As a first step, the existing conditions in factories and workshops were investigated, measurements of illumination being made in rooms of eight factories, including printing, electric lamp-making, lens-making, dressmaking and millinery workshops.

The artificial light was electric in some cases, and high pressure or low pressure gas in others. The portion of mixed lighting found in actual use—i.e., the ratio of artificial to daylight—varied from 1/10 to 8/1, with an average of 3/1. It appeared that so long as the actual illumination was ample, there was no difficulty in working with a mixed illumination of 100 or one of five foot-candles, and generally speaking, the operatives interrogated had no definite views on the comfort or otherwise of working with mixed lighting, provided the illumination was not insufficient.

In order to carry out experiments under conditions controlled in a way which would be impossible in a factory, a room was fitted up at the National Physical Laboratory, so that the proportion of daylight and artificial light, as well as the actual amount of each,

could be carefully regulated. The daylight was variable by alteration of the window screening, while direct, indirect, and semi-direct lighting of any desired amount could also be obtained.

Three classes of experiment were carried out in this room. The first series consisted of a test in which the operator marked with a pin a number of small target diagrams printed on white paper, the marks being made regularly to the beat of a metronome. The test depended on a measure of the closeness of the operator's marks to the centres of the targets.

The second series of tests was that of the rate of reading nonpareil type.

The third series consisted of a test of speed and quality in making a certain size of buttonhole in white and black cloth, under artificial light, daylight, and a mixture of 50 per cent. of each kind of lighting. The results of this series of experiments are given in Appendix IV.

No conclusive results indicating any special effects of mixed lighting were obtained however, and, owing to lack of funds, we are unable at present to extend our investigation of this problem. We are, therefore, not prepared to make any definite recommendations on Mixed Lighting at present.

We desire to express our thanks to the firms who co-operated in this inquiry, especially to Messrs. Debenham's, Limited, and to their workers who took part in the last series of experiments.

OTHER QUESTIONS.

In addition to the main lines of our inquiry, the questions of the best method of lighting glass-bevelling shops, and of the use of translucent instead of transparent glass in factory windows, have been referred to us.

Lighting of Glass-bevelling Shops. This problem was referred to us at the request of a Committee of the Joint Industrial Council for the Furniture Trades.

The bevelling of glass appears to be carried on to a considerable extent by small employers in underground workshops which are, in some cases, very imperfectly lighted. We visited several of these workshops, some of which were illuminated by electric light, whilst others were gas-lighted by means of batswing burners.

The nature of the work necessitates local lighting, which is provided by a lamp placed immediately above and close to the grindstone. Owing to the fact that the workers look directly at the sources of light when examining their work, the source is usually unshaded in the direction of their eyes, and they are, therefore, subjected to unpleasant and often continuous glare.

Our observations and experiments have satisfied us that a bare light source is unnecessary for examination of the glass during the process of bevelling. We think, therefore, that if recommendation (A) of our Second Report is adopted, compliance with it will necessitate the adoption of a method of lighting (such as that described in Appendix V to this Report) which will afford adequate protection of the workers from glare.

While we are of opinion that the needs of the case call for the recommendation of no special requirement, other than that referred to, we wish to take this opportunity of emphasising the desirability of carrying on the work of glass-bevelling wherever possible in workshops in which adequate daylight is normally available.

Use of Translucent Glass in Factory Windows. This problem requires investigation of a special character involving psychological considerations. Such an investigation we have not been in a position to carry out.

Contrast. During the course of our experiments on the subject of mixed lighting, the unpleasant effect of undue contrast between the illumination on the work and that on the surroundings was brought again to our notice. The workers complained of a feeling of strain* when there was little general illumination overhead. We wish to take this opportunity of drawing attention to the undesirability of excessive lighting contrast between the surroundings and the point of work.

Effect of Lighting on Accidents. The Chief Inspector of Factories has supplied, for the information of the Committee, particulars of accidents investigated by the Factory Inspectors in the ordinary course of their duty, during two periods of three months, in which defects in lighting appeared to have been a contributory cause. Owing, however, to the depression in industry, the actual number of accidents has been reduced, and very few of them have been attributable to lighting conditions, as very little work has been done in artificial light. The sample, therefore, was not representative of normal times, and to quote the figures would be misleading. It should be stated, however that the Committee were impressed by the large proportion of fatal falls through ships' hatches, due to inadequate lighting of vessels in dock while coaling or under repair, and also by several instances in factories of accidents due to machinery in which a shadow cast upon a danger point was a contributory cause. The Committee are of opinion that further detailed investigation of accidents over a longer period, with special reference to lighting conditions, is desirable. They feel that such an enquiry would be especially valuable as regards accidents due to " persons falling," which

See Appendix IV, p. 37.

form a large proportion of the annual total of accidents reported to the Factory Department. The latest published return, that for 1920, shows that of 138,702 reported accidents (1,404 being fatal), 17,393 (372 fatal) were due to " persons falling," including 1,175 (40 fatal) which occurred in docks.

CONCLUSION.

Finally, whilst we hope that the adoption of the recommendations made in this report will tend to secure more adequate lighting in factories generally, we desire to point out that, in our opinion, much work still remains to be done before the regulation of factory lighting can be established on a basis of definite legal minima for illumination.

We think, indeed, that, if hardship to employers and much administrative difficulty is to be avoided, any such regulation should be preceded by a careful and systematic inquiry conducted on two main lines:—

(i) the collection, for every process concerned, of a sufficient number of observations to give some indication of the best existing practice;

(ii) experimental research with the object of discovering the conditions of illumination desirable on physiological and psychological grounds.

In this respect, we feel that having regard to the wide field to be covered and the complexity of the problems to be considered, little real progress can be expected so long as the whole onus of the work rests upon a single centralized Committee. In particular, the data we have been able to obtain, extensive as they are, are still incomplete in certain industries, even for the specification of advisory standards. We have, for instance, been unable to examine the important subject of the lighting of shipyards, whilst numerous smaller industries and processes remain to be investigated. Ample proof is now forthcoming of the relation between lighting on the one hand and production and safety on the other, and it seems to us not unreasonable to expect active co-operation on the part of all the principal industries in which lighting is specially important. We wish to suggest, therefore, that on the acceptance of this report, the principal industries specified in Appendix I should be invited to assume partial responsibility for the scheme specified above, by arranging for the collection of the actual data, possibly through the Research Associations where they exist. These data, when properly collated by the Committee, in consultation with the industries themselves, could then be used to afford some indication of existing practice, and would form a most valuable

complement to the more fundamental problem indicated in part (ii) of the scheme, which we suggest should remain under the immediate control of the Committee, namely, experimental research on the conditions of illumination desirable on physiological and psychological grounds.

Owing to existing economic conditions, we are precluded from dealing with these questions at the present time, but we hope that every effort may be made to secure the continuance of our work as soon as circumstances allow.

We wish cordially to thank our two Secretaries, Mr. J. W. T. Walsh and Mr. H. C. Weston, for their services during our inquiry. Our thanks are also due to the Industrial Fatigue Research Board for placing Mr. Weston's services at our disposal.

We are, Sir, Your obedient Servants,

C. DAMPIER WHETHAM (*Chairman*).
LEON GASTER.
R. T. GLAZEBROOK.
C. S. MYERS.
J. HERBERT PARSONS.
ROSE E. SQUIRE.
ARTHUR WHITELEGGE.
D. R. WILSON.

H. C. WESTON, JOHN W. T. WALSH } *Joint Secretaries.*

ABSTRACTS

I.—MALPROJECTION OF THE SPATIAL POINT

Wiseman, E. S.—Cerebral malprojection of the spatial point due to unconscious habit. *Amer. Jl. of Physiological Optics*, January, 1922.

The author introduces his subject by pointing out that in a small percentage of exophorias a " fusion check " will reveal a homonymous, rather than the customary crossed, diplopia.

He briefly records two cases of his own, which illustrate this fact.

The first was that of a woman suffering from about 12 △ of exophoria, and 3 △ of hyperphoria, associated with weak adduction power. Despite a noticeable divergence of one eye under the red glass test, the revealed diplopia was homonymous in type. Exercises to improve adduction materially lessened the exophoria, and produced a diplopia alternating, but tending to remain crossed, within a few weeks.

The second case was that of a man with about 30 △ of exophoria. He exhibited homonymous diplopia with the red glass, which became crossed within a month of commencing muscle exercises.

The author then precedes to locate the "fault of the condition." He excludes the retina, as each eye functioned normally when used singly, or in conjunction, for distant vision; the external geniculate body, which is only a neuronal relay station in the passage of the visual fibres destined for the cortex; the thalamus and anterior quadrigeminal body, the former being related to the reflex movements of visual origin, and the latter to automatic movements of visual origin; and, finally, the terminations of the optic nerve fibres in the cortex, which may be regarded as a definite negative of the retina.

He concludes, therefore, that the fault must lie in the psychical sphere in the cortex.

He assumes the transference of vision from the physical to the psychical field to be accomplished by vibrations, and that each visual fibre has its own cell connection, two cells from corresponding points in each retina lying side by side, and vibrating simultaneously in binocular single vision.

Should a divergence tend to occur, he then argues that a severance between corresponding points must occur, if diplopia is to be avoided, and the mind may then wilfully recognize a relationship between two non-corresponding points.

To explain, therefore, the type of revealed diplopia in the cases under discussion, he thinks that the almost constant vibration of those peripheral nerve fibres in the diverging eye which lie in the direct line of vision, compels the mind, for the sake of harmony, to suppress all other points of the visual field and ignoring the true spatial significance, to interpret their vibrations as corresponding to those produced by the macular fibres in the straight eye.

EUPHAN MAXWELL.

II.—BILATERAL PARESIS OF THE EXTERNAL RECTI IN TABES

Cantonnet, A.—Bilateral paresis of the external rectus muscle in tabes. (La double parésie des droits externes dans le tabes.) *Arch. d'Ophtal.*, June, 1922.

The frequency of paresis of the sixth nerve in tabes (especially in the pre-ataxic stage) is well known. In a short article **Cantonnet** draws attention to the importance of simultaneous paresis of the two external recti as an early symptom of tabes. He expresses the opinion that this condition is extremely rare apart from tabes, and asks if it may not have a diagnostic value approaching that of the Argyll Robertson pupillary phenomenon. Eight such cases —9 males, 1 female—have come under his observation in little more than a year. How is the apparent selective action of the virus on the sixth nerve to be explained? Cantonnet hazards the following hypothesis:—The superficial position of the eminentia teres containing the nucleus of the sixth pair is well known. This nerve is the most readily affected when ocular paralysis follows the intra-rachidian injection of cocain; it is also attacked in diabetes, and it seems probable that cerebro-spinal fluid containing toxic substances may act prejudicially on this nucleus more readily than on others which are not in equal proximity to the ependyma, the ventricular fluid, and the aqueduct of Sylvius. Does this occur in syphilis? We know that syphilitic vasculitis has a predilection for the pia mater; if it be affected would not this nucleus be more prone to attack than those more deeply placed? Anatomical investigation alone will confirm or rebut this hypothesis.

J. B. LAWFORD.

III.—REMEDIES

(1) **Van Lint (Brussels).—Intramuscular injections of milk associated with intravenous injections of neosalvarsan in the treatment of parenchymatous keratitis. (Injections intramusculaires de lait, associées aux injections intra-veineuses de néosalvarsan dans le traitement de la kératite parenchymateuse.)** *La Clin. Ophtal.*, April, 1922.

(1) **Van Lint,** after speaking of syphilitic interstitial keratitis as the test case or touch stone in the treatment of syphilis, tells of his own views and theory as to the success he has had with a combined treatment consisting in the simultaneous use of neo-

salvarsan and milk, the former being given intravenously, and the latter intramuscularly. The results in the three cases tested was undoubtedly superior to any other treatment yet tried. Van Lint expresses his theory thus:—"I was of opinion, founding upon theoretical notions—probably incorrect—that for a maximum effect it was necessary that the organism should be impregnated with salvarsan at the moment of the reaction caused by milk. I said to myself that when salvarsan is injected a large portion of this, acting as antigen, is destroyed by the humoral and cellular reactions of the organism, and that only a minimal amount is available as a spirillicide. On the other hand, an injection of 5 cubic centimetres of milk causes a much more intense reaction of the organism than the usual dose of salvarsan. Under these circumstances may one not suppose that at the moment when the tissues are in defence against the milk antigen the organism is hardly influenced by the salvarsan (*ne peut on pas supposer qu'au moment où les tissus se défendent contre l'antigène lait l'organisme n'est guerre influencé par le salvarsan*). The latter thus escapes the reaction of the organism and is free to exert its toxic action on the treponema of syphilis. Hence the greater effect of the arsenic, equivalent to that of a higher dose." It is obvious that we have here a positive suggestion for the treatment of a rebellious disease that is well worth consideration.

ERNEST THOMSON.

(2) **Dimitry.—Chromium sulphate, a valuable therapeutic agent in eye pathology.** *The Medical Standard*, January, 1922.

(2) **Dimitry** has found chromium sulphate of considerable use in some eye cases. In a woman, aged 52 years, who had lost the left eye from pemphigus of the conjunctiva 8 grains of chromium sulphate were given every 4 hours, and within a few days improvement was noted. Recurrence was successfully treated by the same drug. In a case of severe herpes zoster ophthalmicus hot paraffin was applied to the eruption and chromium sulphate was given every 4 hours in 16 grain doses internally. Dimitry also found that chromium sulphate internally did much good in keratitis dendritica and malarial keratitis. Chromium sulphate was also used with success in blepharitis in phlyctenular and chronic forms of conjunctivitis. In a case of "Descemititis" with vitreous opacities "Descemititis" again cleared up well.

S. S.

BOOK NOTICES

Report of the Committee appointed to select the best faces of types and modes of display for Government Printing. H.M. Stationery Office. 1922. Price, 4s. net.

A Note on the Legibility of Printed Matter. By Lucien Alphonse Legros, O.B.E., M.Inst.C.E. H.M. Stationery Office. 1922. Price, 1s. 6d. net.

Printing is a subject of fascinating interest from many points of view, among which may be mentioned the historical, technical, artistic, physiological and psychological. Hitherto, improvements in printing have been dominated almost entirely by the technical and artistic aspects of the subject. Physiological and psychological considerations have received very little attention, and have had an almost negligible effect upon the evolution of printing. Legibility, however, which should be the absolute *sine qua non* of good printing, depends entirely upon physiological and psychological factors. It is true that legibility has improved in the course of the development from Caxton to the present day, and that there has indeed been a noticeable improvement in modern times, with the striking exception of the productions of some much lauded private and artistic presses; but such improvement has almost never been the result of deliberate endeavours to that end, founded upon scientific investigations and principles. It has been purely empirical, emerging by a process of trial and error from practical experiments, which were undertaken not with a view to any conscious search for greater legibility, but to greater artistic elegance or the whims of master printers.

In 1920 a Committee was appointed by the Treasury to select the best faces of type and modes of display for Government printing. Their report, just issued, is of considerable interest. Apart from the special monograph prepared for the Committee by Mr. Legros, it contains little that is new and affords scanty scientific data for the opinions expressed. The guiding principles are stated thus:—

"The factors which go to make a type face that is at once legible and simple are so many, and involve so many questions of tradition and use, that it is not possible to frame a series of statements which will hold good in all conceivable circumstances and will be true if taken each by itself. But, as a guide to the principles to be followed in the selection of type faces, it may be said, in quite general terms, that the letters should be as simple in form as possible. They should be broad in the face rather than compressed, and should avoid both undue thickening and thinning

of the serifs and strokes or of reducing the whites between them. The faces should be so proportioned that leading between the lines should not be necessary for legibility."

A good deal of discussion is devoted to figures, but the results are not very helpful. In paragraph 18, old face and old style founts are condemned because "the irregularity brought about by the long ascenders and descenders (above and below the line) distracts the eye, and makes it difficult to follow the lines in reading rows of figures arranged in columns across a page." Yet in paragraph 20 it is stated that " if variety can be introduced into the general shape of the blocks, the strain is likely to be diminished, and this consideration furnishes an argument for the use of old face and old style type in mathematical tables which may be thought to outweigh the objections to which we have referred in paragraph 18." The fact that modern style figures are now almost invariably used shows that general opinion does not justify this vacillation. The Committee does not appear to be sufficiently impressed by the following paragraph in Mr. Legros' article. " If a table set in 7-point modern, such as *Chambers' Mathematical Tables* (1878), is compared with a table set in 7-point old style, such as *Barlow's Tables* (1873), it will be seen that in the latter it has been necessary to use horizontal rules after every third line to divide the column into groups, although this is not a natural division for the 50 lines forming a page, whereas in the former there is no difficulty in following the lines in groups of five separated by a fine lead."

The recommendation that " in body sizes up to 8-point recourse should be had wherever possible to figures cast on the two-thick-space set " is excellent.

Babbage, in the preface to his " Table of Logarithms " (1827), laid down the principle :—" The clearness or facility of reading does not depend on the size of the type alone, but on the proportion of the type to the interval between the lines." The Committee paraphrases this dictum thus :—" In other words, a table set in small type adequately spaced is more legible than one in which the figures are in larger type, but are too closely set together." This is not a fair paraphrase, and the Committee seem to confuse " spacing " with " leading." The rules which should govern spacing are certainly not identical with those which should govern leading, which refers to the interval between the lines. There is difference of opinion as to the advantage for legibility of leading, but it is certain that the advantage is almost, if not quite, negligible. In this connection it may be pointed out that the Committee makes no reference to the extremely important fact that the characteristic features of small print are in the upper

parts of the letters. Moreover, whilst 8 letters extend above the line only 4 descend below it, and in an ordinary page of print it will be found that of the long letters about 85 per cent. are ascending and only 15 per cent. descending. In reading, attention is directed to the upper parts of the letters, and if the lower parts of a line of print are covered by a card the print is almost as legible as if they were uncovered. If, however, the upper halves of the letters are covered, it is almost impossible to read the print. Javal has indeed shown that the descending parts of letters can be much curtailed without loss of legibility. The Report is printed in a manner to display some of the Committee's recommendations, and it is to be noticed that the type chosen has long tails to the descending letters.

As regards the display of type the Committee prints 9 examples of the covers of Government publications—as they are and as they should be. They hold that one of the most important principles is " that the type should be, as far as possible, of one fount and of the same family as the letterpress." Most people will agree that so far as *appearance* is concerned this is true: but we have no hesitation in saying that so far as *utility* is concerned it is not true. The very first requirement of printing is legibility. In the printing of covers and title pages the most important parts should be made to stand out as clearly and forcibly as possible, and this can be best effected by a different fount of type from that used elsewhere on the page. This fact is surely proved to the hilt by the universal employment of capitals, small capitals, etc., for headings, and Clarendon or heavy type for sub-headings. In purely artistic publications it may be justifiable to compromise with legibility and pay more attention to the beauty of the printed page as a whole; but in most Government publications, text-books, and so on, every possible aid should be given to quick recognition of essentials, and every impediment to legibility should be ruthlessly condemned. For this reason we also disagree with the Committee's recommendation that " the use of extra-condensed types should be avoided; the difficulty of setting a long title can obviously be met by spreading it over two or more lines." A single line of large condensed type can often be grasped at a glance, whereas two or three lines cannot.

The Committee does not express any definite opinion on the length of line which is permissible with different sizes of type. This is a very important point. Cohn gives 90 mm. as the ideal length. Lines longer than 100 mm. throw an undue strain upon the accommodation, render it difficult to pick up each succeeding line, and involve greater range of movement and expenditure of muscular energy. Lines extending the whole width of a folio page (as in Mr. Legros' Note) are far too long. The Committee

appears to recognize this fact, since its Report is printed in double columns. They recommend that the rule (or black line) which is often used to separate the double columns in Reports of Parliamentary Debates, etc., be omitted, and the columns separated simply by a white interspace, the width of the white to vary with the size of the page and the measure of the columns.

It will be gathered, from what has been said, that the Report embodies the opinions of the Members of the Committee, opinions which are not founded on indubitable scientific evidence, and which are therefore ill-adapted to resist criticism. As might have been expected from the constitution of the Committee, the traditions of printers and the canons of artistic printing have outweighed scientific principles. It is to be regretted that the investigations of Cattell,* Erdmann and Dodge, Huey and Delabarre, Lamare and Javal, Cohn, Weber, and others, including the important communication of Mr. Legros, himself a member of the Committee, have not been sufficiently considered and allowed to influence the recommendations more effectually. We consider that by far the most important recommendation of the Committee is the last:—"*The Medical Research Council should be approached with a view to the inception of an enquiry on physiological and psychological lines into such questions as legibility and the optical properties of paper and ink with reference to eye strain.*" If the Committee had begun with this recommendation and insisted on its being acted upon, instead of relegating it to the end of their Report, we think that the thousand pounds which they have expended might have been more profitably used.

Mr. Legros' Note on the "Legibility of Printed Matter" is an extremely interesting and valuable *résumé* of the present unsatisfactory state of the subject, and is specially important as embodying his own researches. Its weakness is that it deals with the question essentially from the point of view of the physicist, and does not pay adequate attention to the far more important physiological and psychological problems involved. Thus, from the physical point of view his legibility co-efficient, percentage of blackness and specific legibility are very ingenious and embody an important principle, though they are of but limited application and may be wrongly applied. The legibility co-efficient is the ratio of the coincident area to the total area of letters which are easily mistaken for each other. Blackness is the ratio of the total area of the inked surface of a letter to the cross section of the shank of the type, expressed as a percentage. Specific legibility is the product of the mean legibility co-efficient (taking account of

*We doubt if Prof. Cattell, a distinguished American psychologist, would appreciate being described as "of Leipzig." (See Mr. Legros' note, p. 2.)

the frequency of occurrence of the characters) by the mean blackness. Now, as Mr. Legros agrees, " with increasing blackness, other conditions remaining constant, the coincident areas increase, and the legibility co-efficients decrease." But it is well known that legibility is improved as the size of type diminishes by increasing the thickness of the most characteristic parts of the letters, as may be easily seen by comparing the ordinary founts of type, such as Jaeger's types, with types reduced to equal size photographically, as in Snellen's test types for near vision, which are founded on the same principle of visual angle as Snellen's distance types. Moreover, except for children learning to read, or adults reading figures, individual letters are not specially attended to, but the characteristic parts of groups of letters. In fact, " specific legibility " deals rather with relatively undifferentiated light sense, which may be regarded as the primitive form of vision, rather than with the highly differentiated form sense of man, which is still further elaborated psychologically in the process of reading. At the same time we regard this mode of dealing with one of the problems of legibility as a great step in advance, probably susceptible to great and valuable elaboration, making it applicable to the more complex problems of reading, when they themselves have been further elucidated.

When the enormous importance of reading in modern civilized life is contemplated it is extraordinary that so little attention has been paid to the subject by physiologists and psychologists. The stimulus to investigate the subject at all originated in the exigencies of ophthalmology, and bore fruit in the invention of Snellen's test types. We, as ophthalmologists, in some degree guardians of the eyesight of the people, may well consider it our bounden duty strongly to support the recommendation of the Committee that the physiological and psychological factors of reading should be investigated under the aegis of the Medical Research Council.

OBITUARY

WE announced in the last number of the Journal the death of Mr. E. H. E. Stack, the well-known ophthalmologist, of Clifton, Bristol, who died at the age of fifty-five years in King's College Hospital, Denmark Hill. He was born on December 15, 1866, at Langfield, Co. Tyrone, when his father, Canon Stack, of Londonderry Cathedral, was Rector. He was educated at Haileybury, Cambridge, and St. Bartholomew's Hospital. He took the widest possible interest in all departments of Medicine and Surgery, and at St. Bartholomew's

Hospital won the Brackenbury Medical Scholarship and held more resident appointments than anyone before or since. In 1897, Stack went to Bristol as House Physician to the Royal Infirmary, after taking the diploma of F.R.C.S. In 1902 he became House Surgeon, and in 1906 was elected Assistant Surgeon. On Dr. Ogilvy's death he decided to specialize in eye-work and was appointed Ophthalmic Surgeon to the Royal Infirmary in which post he continued until his death. Later, he succeeded to a vacancy as Surgeon to the Bristol Eye Hospital. Stack spent several years abroad in Paris and Vienna studying Surgery. In 1920 he started the South Western Ophthalmological Society and arranged their quarterly meetings in Bristol. His was a familiar face at the Oxford Ophthalmological Congress where he invariably exhibited optical and other instruments; he was also a member of the Council and represented the Congress on the Council of British Ophthalmologists. His powers of teaching were remarkable and he was very keen on the welfare of the medical students, both at work and socially. During the war he did much fine work at the 2nd Southern General Hospital at Bristol and at No. 56 General Hospital in France. He did not make many contributions to the literature of ophthalmology, his inclination being rather to the clinical side of the work. He leaves a wife and four children to mourn his loss.